Network Centric Warfare: An Emerging Warfighting Capability

CSC 1998

Subject Area - Warfighting

EXECUTIVE SUMMARY

Title: Network Centric Warfare: An Emerging Warfighting Capability

Author: Major Donald G. Wogaman, USMC

Thesis: The U. S. Navy has set a course that implements a vision of Network Centric Warfare (NCW) aboard all vessels, to include amphibious ships. This implementation will have a significant effect on the systems afloat that support Marine Corps Command and Control (C2). The Marine Corps must participate fully in the shaping of naval NCW or it risks having to operate from platforms ill-suited for its C2 of today as well as its OMFTs vision of the future.

Discussion: The period following the Cold War has provided U. S. naval forces the opportunity to review the concepts and doctrine on which their capabilities are based. This review has shown that many of the concepts, to include command and control, are in need of considerable revision to support future warfighting requirements. This review process has come a long way towards recognition of amphibious and littoral warfare as the centerpiece of naval warfare.

Coupled with an explosion of information technology capabilities, a new concept of Network Centric Warfare has emerged that places information networks at the center of our warfighting. This concept potentially allows for the development of greater situational awareness and faster speed of command, an important enabler of maneuver warfare.

The resulting implementation of command and control concepts through its Information Technology for the 21st Century (IT-21) program goes a long way towards providing NCW capabilities to naval forces, but needs further input from the Marine Corps to be able to fully support MAGTF requirements.

Conclusion/Recommendation: The Marine Corps needs to become more closely involved in this implementation.

Report Documentation Page

Report Documentation Page						*Form Approved* *OMB No. 0704-0188*
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.						
1. REPORT DATE **1998**		2. REPORT TYPE				3. DATES COVERED **00-00-1998 to 00-00-1998**
4. TITLE AND SUBTITLE **Network Centric Warfare: An Emerging Warfighting Capability**						5a. CONTRACT NUMBER
						5b. GRANT NUMBER
						5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)						5d. PROJECT NUMBER
						5e. TASK NUMBER
						5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Marine Corps War College,Marine Corps Combat Development Command,Quantico,VA,22134-5067**						8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)						10. SPONSOR/MONITOR'S ACRONYM(S)
						11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release; distribution unlimited**						
13. SUPPLEMENTARY NOTES						
14. ABSTRACT						
15. SUBJECT TERMS						
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON	
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**51**		

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

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Network Centric Warfare (NCW) is a term that has emerged from the American and worldwide information technology explosion and is currently used by the United States Navy to describe its view of the direction in which information concepts will evolve.[1] Applications of NCW are already supporting the United States Armed Forces across the entire spectrum of capabilities; these applications only hint at the immensely powerful information capabilities yet to evolve.

For the ground oriented Marine, the immediate application of NCW may seem elusive, but when applied in the context of the technology sparse environment of the Marine Air-Ground Task Force (MAGTF), NCW is simpler to understand. One of our commanders' greatest challenges is to maintain situational awareness of the location of his own forces. Several systems have been developed to support this with technology, among them, the Global Positioning System (GPS). GPS provides portable systems that accurately locate themselves on the battlefield, but do not provide an automated, integrated system for reporting that information.

To build a theoretical NCW model within a MAGTF, we need to make several assumptions: First, all Marines, including pilots of aircraft, know their location with GPS. Second, each has access to a communications path that will support the information flow to be described in this model. This MAGTF can now know the location of every Marine. Automating this process, the MAGTF now has a database that can be queried or manipulated, locally or remotely, to provide the location of every Marine.

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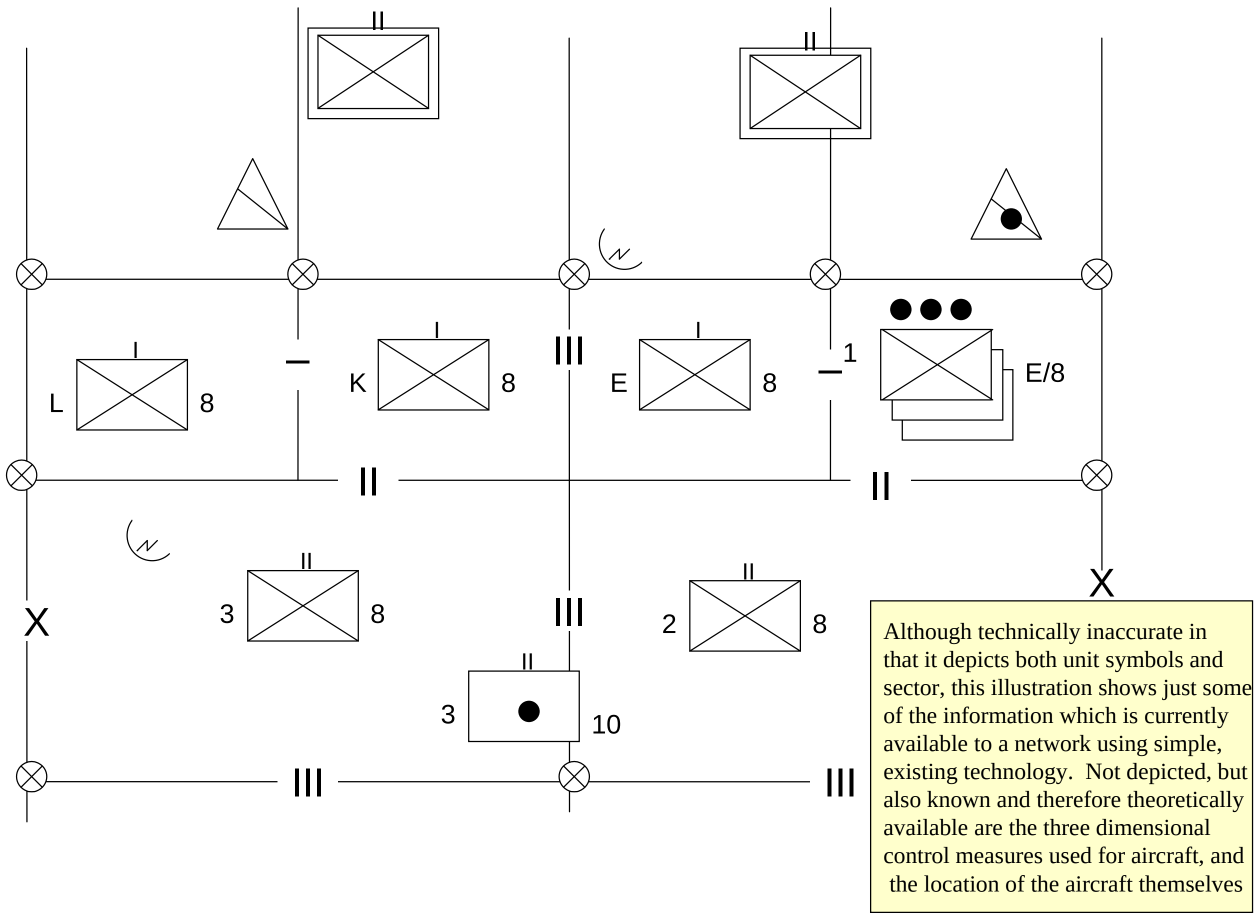
[1] VADM Arthur K. Cebrowski, USN. Director, Space, Information Warfare, Command and Control (CNO-N6). "Network Centric Warfare: Its Origins and Future." Proceedings. January 1998. p.29

The next step is to provide this information to every weapon system that uses automation to compute firing solutions: artillery, naval gunfire, and some aircraft (for this model assume all aircraft). Each weapon systems' firing solutions can automatically avoid friendly units by using positional information provided across this network.   Taking this model one step further, provides those units with target identification or designation capability the ability to automatically feed this information into the network.   By accessing the information from units that identify or designate targets, both ground and air weapon systems' automated firing solutions can be computed and deconflicted in real time.

To add additional capability, this network can be expanded by connecting several elements of the Marine Air Command and Control System (MACCS). The Direct Air Support Center (DASC), the agency that coordinates requests for Close Air Support (CAS) can make the network aware of available aircraft and armament. Other connected systems can provide infinitely expanding amounts of information.

Once the ground unit, the fire support systems, and the coordinating agencies have been connected it is possible for the network to facilitate coordination and provide fire support at the speed of electricity. Given the appropriate computing power, the network can now identify all of the elements of the fire support equation; the location of all friendly units, the location of all firing units, their capabilities, and even the commander's priorities. By simply identifying a target, all firing systems in the network can compute firing solutions and either the network itself, or a human operator can select the appropriate system. The Forward Observer (FO) or Forward Air Controller (FAC) can now receive fire support as fast as the selected system can deliver it.[2]

[2] Author's Note: A position reporting system for a ground maneuver unit that does not provide real-time reporting of all elements, such as individual infantrymen, vehicles or aircraft, will always require the system to make an assumption, based on doctrine, and perhaps updated by the particular situation, that those non-reporting elements of that unit are within a given distance of a



The Point is that the network and all of its' elements are at the center of our warfighting capability. The key strength of the United States Armed Forces is the ability to harness the power of information and turn it into a warfighting advantage. Using a network that shares what the MAGTF knows with all of its' elements provides each element with a critical ability to use

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reporting element. This poses two problems. First, it places those elements at risk when they maneuver outside of the "protected area," and second, it places an additional restriction on the maneuver unit commander in the form of pressure not to maneuver outside of that area.

A better and more practical, as well as achievable alternative may be to use the system to identify a particular unit with whom a firing unit must deconflict. In other words, when a firing solution is achieved, the firing unit identifies the closest maneuver element or one identified within the network as responsible for a given area and automatically queries that unit for clearance to fire. The solution could be presented as an illuminated target on a map screen, for example. The unit FSC could clear almost instantly, given his own knowledge of the locations of non-reporting units. In the case of fires requested by the unit the system determined to be closest to the target, the clearance steps could be bypassed.

that power. The power of the network in this theoretical model is expanded exponentially by connecting it to the resources available across the Department of Defense (DOD).

There are many concurrent applications of NCW across DOD. Just in time logistics and total asset visibility will require information flow across the network from the shooter of ammunition to the manufacturer of ammunition to facilitate the flow of material. If the shooter can automatically update ammunition usage, while firing, the network can begin manufacturing and moving replacements without human interface. Deployed medical personnel now routinely link real time, via VTC, to doctors and databases in the United States to access information and experience. In each case, by using the network to access capabilities, a tremendous savings in time, deployed personnel and equipment is realized.

It should be clear that despite the fact that all of the information discussed in the model is currently known and processed by at least one or more systems, collectively or individually the Armed Forces are a long way from the all-seeing, all-knowing, MAGTF in this model. Leveraging the power of information now available is central to the goals of each service, but because of differences in capabilities and command and control doctrines, the visions and desired shape of our joint information architecture are very different.

There are several popular descriptions of the concept and elements of NCW in vogue. In the most frequently cited description, elements of the network that provide either friendly or enemy situation information are part of a sensor plane. The elements that shoot or contribute directly to the development of firing solutions are part of a shooter grid. The elements that move the information across the battlespace are part of the information grid. Together, these three grids provide the elements of the NCW concept.[3] This can be misleading, as it conjures an image

[3] United States Dept. of Defense. Observations on the Emergence of Network-Centric Warfare. Joint Chiefs of Staff J6. available HTTP://131.84.1.34/JCS/J6/Education/Warfare.HTML 18 Jan 98.

of three distinct separate entities. On a larger scale it may be easier to think in terms of a network that connects sensor, shooter and decision support capabilities without reference to grids or planes.[4]

Why is it important for the Marine Corps to understand this? Because of its fundamental warfighting nature, the Marine Corps has unique concepts and doctrine for command and control (C2), maneuver, fire support and other elements of warfare. Our C2 systems must support these unique Marine Corps ideas. Operational Maneuver From The Sea (OMFTS) and related emerging concepts clearly imply that more and more of our warfighting will be conducted from amphibious platforms, with command and control frequently staying sea based. The U. S. Navy has already embraced and has firmly embarked on a course that implements a vision of NCW aboard all vessels, to include amphibious ships. This implementation will have a significant effect on the systems afloat that support Marine Corps C2. The Marine Corps must participate fully in the shaping of naval NCW or it risks having to operate from platforms ill suited for its C2 of today as well as its' OMFTS vision of the future. In this paper I will discuss the immediate impact of the U.S. Navy's implementation of NCW on the amphibious MAGTF, as well as some of the important considerations for the Marine Corps regarding NCW.

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[4] Rex A. Buddenberg, Lecture Notes. http://web.nps.navy.mil/~budden/lecture.notes/sheared_net_centric.html. April, 1995, revised October 1995. With subsequent personal E-Mail.

HISTORY

The Navy's current doctrinal development has come about because of significant changes in thought regarding command and control. The explosion of information technology resulting from the growth of both computing and transmission system capacity, has changed the fundamental view of Navy command and control doctrine.

From the beginning of sail and through the development of steam power, ships and naval task forces have been isolated from their higher headquarters by the vast expanse of the sea. Once he received orders, a commander would sail out of contact to execute a mission that might take months or years. This produced commanders who cherished their independence, but who also were comfortable working with the capabilities their vessels provided. The commander, who could control all aspects of the force, became the center of the force. If additional warfighting capability was required, it was added to the platform on which it was required and the commander given the ability to control it. Hence, if a ship needed the capability to defend against a particular threat, it was added to the ship or task force and controlled by that ship's commander. This "Platform Centric" mind-set has dominated the evolution of naval technology.

If a new threat emerged, a new capability was developed to counter it. This capability was developed in isolation from the other capabilities either elsewhere on the same platform or within the fleet. There were different systems for different threats with no linkage between the two. The developers of systems thought only in terms of the specific capability in its design.

As technology advanced, the adherence to this business process began to create a gap between the potential presented by technology and the actual use. Emergence of high frequency-long range radio systems utilizing morse code, teletype, and then voice, ultimately gave way to the leveraging of space with satellites for radio relay, the capacity to process enormous amounts of data with computers, and the ability to move this data efficiently as digitized information. As newer information technologies emerged and new sensor or shooter capabilities were developed, they continued to develop in isolation. Such systems or capabilities are now referred to as stovepipe systems, defined by the Defense Information Systems Agency as, "A system, often dedicated or proprietary, that operates independently of other systems. The stovepipe system often has unique, nonstandard characteristics."[5] Copernicus... C4ISR for the 21st Century states, "Historically, systems could only exploit specific tactical sensor capabilities to engage a specific threat. This made it difficult for different platforms, other services and allies to share time-sensitive information. This often excluded national assets."[6]

These stovepipe systems evolved to an extreme: During World War II, for example, air defense individual ships had antiaircraft weapons, radars and the Combat Air Patrol (CAP) tied with voice and teletype. Although reasonably effective, the losses to "leakers" were far too costly. As a result, missile systems and tactical data links were developed utilizing emerging technology to enhance the air defense capability. Air defense also drove the development of the Navy Tactical Data System (NTDS), which provided the overall air defense picture.

At the same time, naval logistics took advantage of emerging computing technology and procured large mainframe systems to process the significant amounts of logistics data. These systems could not interface with either NTDS or the other Anti-Air Warfare (AAW) systems.

Antisubmarine Warfare (ASW) evolved along a similar track. As submarine stand off ranges increased, helicopters were used to increase sensor range. Because the computing

[5] United States Defense Information Systems Agency. Defense Information Master Plan Version 6.0. 27 June 1997. p. GL-16.

[6] U. S. Dept. of the Navy. Copernicus: C4ISR for the 21st Century. http://copernicus.hq.navy.mil/forward/index.html. C4ISR is Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance.

capability required was too heavy for in-flight applications, special data links were developed that were incompatible with AAW systems.

The addition of satellite technology rounds out the picture. Rather than develop ways to share capacity, each warfare community and military service was provided a share of the scarce satellite capacity. Instead of driving inter-operability, this common system caused conflict over "pie share."[7]

The Marine Corps PLRS system provides a good example of a stovepipe. In development for 20 years, it emerged in force roughly the same time as the Global Positioning System (GPS), PLRS was unable to provide its valuable friendly situation information beyond its closed system. It should be noted that stove piping does present some advantages. Most notably, information or capabilities within a stovepipe are not vulnerable to damage to other systems. Damage to the stovepipe system is contained within the stovepipe.[8]

At the peak of the development of the numerous stovepipe systems, the Navy revisited its C2 concept with a view towards developing oversight over the entire Command, Control, Communications, Computer and Intelligence (C4I) picture. The result was the publication, in 1989, of a concept called Copernicus, a revolutionary change in C4I doctrine.

Copernicus recognized numerous flaws, including: A lack of total C4I oversight; lack of jointness; information overload caused by a message capacity grown beyond human capacity to absorb information; completely incompatible information formats; loss of operational focus

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[7] The air defense example used on pages 5 and 6 is drawn from: Rex A. Buddenberg. Lecture Notes. http://web.nps.navy.mil/~budden/lecture.notes/sheared_net_centric.html. April, 1995, revised October 1995.

[8] LtCol (Col sel) Robert R. Logan, USMC. Marine Corps Combat Development Command C4I Branch. Personal interview October 1997 and subsequent E-Mail 26 March 1998.

within technology, i.e. technology for its own sake; and a procurement system that was incapable of keeping pace with technological development.

To correct this, Copernicus envisioned a C2 doctrine embodied in the Composite Warfare Commander (CWC) concept. Information management would be accomplished through communications and computers. Intelligence and sensor processes would develop coherently. Copernicus also foresaw the post-Cold War environment of shrinking budgets and manpower, but with ever strengthening potential to leverage information technology.

Copernicus also presented a vision of a global C2 structure with four primary pillars:

1) Global Information Exchange networks (GLOBIXS), which linked the strategic and operational levels and would be managed by the Defense Information Systems Agency (DISA);

2) Commander In Chief's (CINC) Command Complex (CCC), which supported the CINC or JTF Commander and provided the gateway between operational and tactical;

3) Tactical Data Information Exchange Systems (TADIXS), which connect the CCC to the next pillar below:

4) Tactical Command Center (TCC) via multi-band transmission media. The TCC consists of the Composite Warfare Commander (CWC) in either the Tactical Flag Command Center (TFCC) or Combat Information Center.

A critical tenet of Copernicus is the realignment of acquisition. Incompatible or inefficient programs would simply be dropped, and replaced by systems with commonality and simplicity as key features.

During the early stages, there were several fundamental problems with Copernicus that were important to the Marine Corps. First, amphibious warfare was not included, nor any other reference to jointness. At the time, the Navy had not yet grasped the significance of the Soviet Union's demise which ended the requirement to fight for control of the sea. Copernicus also omitted tactical systems, or those which would link the CWC in the TCC to the assigned forces. It was not Network Centric because it envisioned each command center as a gateway to the next in an artificially reinforced hierarchy. Lastly, the envisioned systems did not share information amongst themselves, they simply shared a common transmission media.

Subsequent developments in the evolution of Copernicus saw several trends emerge. Recognition of the littorals as the battlespace of the future firmly cemented the realization within the Navy that its key to the future was the Marine Corps. The Navy also recognized that naval forces were only one element of a joint force. Within the realm of information technology the network emerged as the clear key to information dominance.

A subsequent series of eight Navy and Marine Corps concept publications produced following Copernicus developed these trends clearly. From the Sea highlights the Navy-Marine Corps team, and introduces the Naval Expeditionary Force. It also shows greater recognition of joint requirements with a tasking to "Configure, train and man numbered fleet and Marine expeditionary staffs to be able to command a joint task force and function as, or host, a Joint Force Air Component Commander," and to "Enhance communications, command, and control on naval flag ships to the degree necessary to host the commander of a joint task force."[9]

Forward... From the Sea establishes the Carrier Battle Group (CVBG) and Amphibious Ready Group (ARG) NEF basic building blocks. Theater Missile Defense (TMD) is identified as a critical capability.[10]

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[9] U. S. Department of the Navy. Navy and Marine Corps White Paper. ...From the Sea: Preparing the Naval Service for the 21st Century. http://www.ndc.navy.mil/FTS.html. September 1992.

[10] U. S. Navy. Secretary of the Navy. Forward... From the Sea.. http://ndcweb.navy.mil/htdocs/ffts.html. 19 September 1994.

Operational Maneuver From the Sea (OMFTS) shows true recognition of the Navy-Marine Corps partnership by identifying maneuver of naval forces as the heart of OMFTS. It also identifies an important requirement for information systems to avoid information overload while supporting the commander's information requirements- "Communications systems designed to provide a few headquarters with an overall view of the situation will be replaced by those that provide units with control over the information they need." OMFTS also states a clear requirement for NCW, "The command and control capability to integrate all aspects of the power projection operation. This includes overall integration of joint and naval assets. ... Additionally, a common battlefield perception must be provided to all levels, presenting information appropriate for the level of command or function."[11] It is important to note that to date, the Navy still has reservations about OMFTS.

Copernicus... Forward/C4I for the 21st Century significantly updates the Copernicus concept. This is where the NCW concept of 3 grids emerge, although only partially developed:

> "Conceptually, platforms are linked by moving information around the information spectrum. The information spectrum consists of three integrated grids.
>
> Surveillance Grid: A capabilities grid blanketing the battlespace instead of a series of single sensors. This grid consists of national, theater and platform sensors that the warfighter can access directly or through GLOBIXS and TADIXS.
>
> Communications Grid: An overlaying wide area network of pathways that use multiplexing and digital technology to move data and information into and around the battlespace. Copernican connectivity facilitates the movement of information among operators and analysts.
>
> Tactical Grid: A tactical network of communications links that ties together all units of a force regardless of the platform or component. This grid connects the Combat Direction Systems (CDSS) among units' TCCs to provide fire control grade information across the Battlecube to the shooters. The BCIXS can "plug" and "play" to access C4I information directly by using TADELs tied to higher echelon TCCs and the tactical grid itself."[12]

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[11] U. S. Marine Corps. Commandant of the Marine Corps. Operational Maneuver From the Sea. 1996.

[12] U. S. Chief of Naval Operations. Copernicus... Forward : C4I for the 21st Century. http://www.chinfo.navy.mil/navpalib/policy/coperfwd.txt. 1995.

The BCIXS identified above is Battlecube Information Exchange System (BCIXS), which "extends [the Copernicus] architecture to include the battlecube, the space in which shooters and weapons reside."[13] This critical element was clearly missing from the original Copernicus document. Also presented are several essential NCW concepts: Common Tactical Picture (CTP), where each commander's view of the battlespace, regardless of air, sea or land orientation, is produced from the same sources. The Joint Maritime Command Information System (JMCIS), is identified as the primary enemy/friendly situation viewing/processing application, and it also recognizes that sufficient bandwidth is an essential precondition for NCW.

2020 Vision...A Navy for the 21st Century recognizes the minimal requirement to prepare for war at sea and nuclear deterrence, while highlighting littoral warfare, and by implication, the role of the Marine Corps. Four naval roles are identified: Forward Presence; Deterrence, both conventional and strategic; Sea Control, with an emphasis on dominating the enemy's littoral; and power projection. Power projection is broken down into precision operations, strategic sealift and expeditionary operations, with expeditionary operations consisting of joint maneuver from the sea and sustainment from the sea.[14]

Forward... From the Sea 1997 further embraces potential joint roles and the Marine Corps. It emphasized naval capability to provide sea based surveillance and reconnaissance as well as sea based command and control for levels of command up to the Joint Task Force (JTF) Commander. Naval systems will provide a CTP and will be fully interoperable in the joint world. "Our Cooperative Engagement Concept will provide unprecedented level of battlespace

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[13] Copernicus... Forward C4I for the 21st Century.

[14] U. S. Dept. of the Navy. 2020 Vision: A Navy for the 21st Century. 1996.

awareness and combat power by linking the sensors and weapons of an entire force into a highly integrated network."[15] The Navy and Marine Corps will be full partners in OMFTS.

A Concept for Ship to Objective Maneuver , published by the Marine Corps in 1996, acknowledges that NEF Commanders may be responsible for overall accomplishment of an amphibious mission. It also provides a clear statement that a MAGTF command element must be able to operate from aboard ship. Together, these two tenets firmly dictate a requirement for unity of purpose in developing amphibious command and control systems.[16]

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[15] U. S. Navy. Forward... From the Sea: the Navy Operational Concept. http://www.chinfo.navy.mil/navpalib/policy/fromsea/ffseanoc.html. March 1997.

[16] U. S. Marine Corps. A Concept for Ship-to-Objective Maneuver.

THE PRESENT

Copernicus... C41SR for the 21st Century is the current Copernicus concept authored jointly by the Navy's N6 staff and Marine Corps Combat Development Command's C4I Branch, and signed by both the Chief of Naval Operations and the Commandant of the Marine Corps. It states that the goal of NCW/Copernicus is "to drive the complexity and tempo of the battlespace beyond the C41SR capabilities of the enemy by enabling speed of command."[17] It further states that "In the information era, information and information technology are no longer considered simple enhancements to warfare. Instead, they should be viewed as military objectives, just as land, people, natural resource and capital were held in previous eras."[18]

Common Tactical Picture (CTP) stipulates that "All warfighters share the same scaleable picture and can extract the pieces relevant to their specific needs, tactical situation and level of command."[19] It consists of "intelligence, surveillance, reconnaissance, identification, environmental & positioning inputs, tactical decision aids and predictive modeling."[20] Another way of understanding CTP is to say that it is the total of all the sensors presented via some form of human interface. Given the current state of technology, the ability to generate a Joint Task Force (JTF) wide CTP may still be beyond our capability.

A closely related concept, but not addressed in Copernicus... C4ISR for the 21st Century, is that of the Common Operational Picture (COP). Mr. Martin C. Jordan, the Navy's Space and Naval Warfare Systems Command (SPAWAR, 051) Chief Engineers Office, and Commander, 7th Fleet Science Adviser from 1994 to 1997, distinguishes CTP and COP this way:

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[17] U. S. Dept. of the Navy. Copernicus: C4ISR for the 21st Century. http://copernicus.hq.navy.mil/forward/index.html.

[18] Copernicus... C4ISR for the 21st Century

[19] Copernicus... C4ISR for the 21st Century

[20] Copernicus... C4ISR for the 21st Century

> I see the CTP being built out of information obtained from Tactical Sensors (Links, radar, some acoustic, EW, ELINT, national sensors, etc.) where the data update rate is in the milliseconds to seconds range. It portrays the dynamics of the battlefield for tactical planning. In the traditional hierarchy, I would see this as the domain of units, up to the BG/ARG.... those actually doing the shooting or directly directing those who do.
> COP is composed of data which is typically updated in terms of tens of seconds to minutes (e.g. Links, OTCIXS/JMCIS, TADIXS), but can also overlay the CTP. COP is used for operational planning of the battlefield, Crisis Action Planning and (again in my mind) more the domain of the BG/ARG, FLEET/MEFs, JTF Commanders and/or CINCs - those involved with the "big picture." These are the people who are making the plans and policy and directs those who direct the shooting - the BG/ARG/MEUs are caught in the middle here.[21]

In the near term, this will be provided by JMCIS and Global Command and Control System (GCCS). CTP and COP are critical to NCW, for they allow Commanders to know that they are seeing the same data as those with whom they must coordinate. It may present a different aspect; for example, an air commander does not need the same information as ground commander, but each view of the CTP or COP is derived from the same source.

According to <u>Copernicus... C4ISR for the 21st Century</u>, these elements then allow for Speed of Command, the goal of NCW. <u>Speed of command</u>, "<u>flattens hierarchy</u>, frees the information systems from command systems, puts decision makers in parallel with shooters and <u>transforms command from a step function to a continuous process</u>. This <u>reduces operational pause</u> associated with decision making and <u>eliminates an enemy's opportunity to regain the initiative</u>."[22] In effect, NCW provides a far faster decision cycle.

It is possible to draw some critical lessons from this series of documents. First, although it has evolved slowly, NCW now permeates Navy and naval C2 concepts. These in turn have only slowly embraced the Marine Corps and Littoral Warfare. Copernicus was developed to

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[21] Mr. Martin C. Jordan. Space and Naval Warfare Systems Command Program (SPAWAR, 051) Chief Engineers Office, and Commander, 7th Fleet Science Adviser from 1994 to 1997. E-mail 30 March 1998. Available from the author.

[22] <u>Copernicus... C4ISR for the 21st Century</u>

fight the war at sea more effectively and has over time become applicable to littoral warfare. It is unreasonable to expect any institution whose fundamental tenet has been naval warfare through sea control and war at sea to make a rapid shift to supporting land warfare. This involves a change of corporate mind-set that will transition over generations of career mind-set. It could as easily shift back given the right circumstances. Second, Marine Corps concepts (STOM/OMFTS) are tying us ever more closely to shipboard command centers. Now more than ever, the Marine Corps is tied firmly to what the Navy builds in amphibious ships.

From these two points it can be concluded that the Marine Corps cannot reasonably expect the Navy to build to Marine Corps requirements without very close Marine Corps involvement in the Navy's C4 requirements development, vetting and funding process. The next step is to look closely at the Navy's implementation and assess its impact.

A CLOSER LOOK AT NCW

The NCW concept is very broad, as are the definitions of its sub-elements, the three grids or planes; sensor, shooter (or engagement), and information. Each can perhaps best be defined by describing the elements in it. It is important to note that a single element can belong to more than one grid if it is capable of more than one function. Precise definitions or location of functions are not important as long as access to the network functions is unimpeded.

Sensors are the eyes and ears of the network; the broadest interpretation of this includes any element that provides information on the enemy or friendly situation to the network.. This also can be interpreted to include human senses, the best sensors the Marine Corps (and the Army) has. Clearly, one of the challenges the Marine Corps and Army face is taking the product (what the individual rifleman sees, hears and feels) and providing this to the network, while at the same time not literally overburdening the individual rifleman with the weight of technology nor overloading the network with information.

At present, most sensors are the product of a design process that did not envision the possibility of sharing information beyond a specific application. The antisubmarine helicopters designed to support ASW as discussed earlier were designed with the sole purpose of identifying submarines. As a result, sonar and other systems were developed solely to support engagement systems for enemy submarines. What else could this platform sense and provide to the network?

Succeeding generations of sensor capability will need to be designed with the purpose of providing information to the entire network. Additionally, sensors need to be shaped to combine information to best support the commander's requirements. It may then be possible to have sensors that will support multiple, otherwise unrelated, shooter or engagement capabilities. This is referred to as data fusion.[23] The overall data fusion concept must be developed with the intent of taking raw data, processing it into knowledge, and ultimately, understanding the total situation.[24]

The potential for understanding any tactical situation will increase significantly, based on an ever increasing range of possibilities from air, sea, ground, space and cyberspace based sensors. Commanders and those responsible for development of intelligence collection plans will be able to approach information dominance with the question "what is it possible for me to know?" Sensors with multiple capabilities also present the possibility of reducing their total number within the battlespace, thereby reducing friendly signature.

The possiblity also emerges for Commanders to focus sensor capabilities on specific information requirements at specific times and places. This process is known as dynamic tasking[25] or information agility.[26] The theory is very similar to the process of developing Commander's Critical Information Requirements (CCIR), whereby specific events or "pieces" of information are identified as critical to understanding total situation.[27] Dynamic tasking of the network's sensors is the process of focusing those sensors to support CCIRs.

There is considerable overlap between the sensor and information grids. Also referred to as the transport grid, it moves information between the others, or more descriptively, moves information between people, places and things. It connects all elements of each plane.

At present, the information grid does little more than connect systems with a common transmission path. The Secure Internet Protocol Router Network (SIPRNET) and Non-secure

[23] U. S. Joint Chiefs of Staff J6. "Information Paper: Observations on the Emergence of Network Centric Warfare." http://131.84.1.34/jcs/j6/education/warfare.html. p. 5.
[24] U. S. Marine Corps. MCDP 6: Command and Control. GPO. 1996. p 67.
[25] Information paper page 4
[26] LtCol Logan interview.
[27] MCDP 6 Page 120.

Internet Protocol Router Network (NIPRNET) are examples that best illustrate this, although it is important to note that they are not all-inclusive. Numerous applications are now connected across these networks. If however, they were not developed with the intent of sharing information with other applications, it is likely they are incapable of doing so. Such systems are "stovepiped."

Multiple networks can also restrain the network's capability. The best examples of this are the different networks that exist because of security considerations. In general, different levels of security, from top secret to unclassified, including Allied or coalition networks, such as the North Atlantic Treaty Organization's (NATO) Crisis Response Open Network Operating System (CRONOS) are difficult to connect because of the concern for a security compromise across a lower level network. This currently recognized challenge makes it quite difficult to share information across the whole information grid. Unless solved, this challenge makes effective data fusion by the network difficult, and the commander will have to look at multiple layers of highly developed information from each network and "fuze" that information "manually."

It is important to note that for the present, multiple networks provide the advantage of redundancy. A single network can represent a single point of failure. The density of the network itself provides some redundancy, but for a single network there will likely always be identifiable, and therefore targettable, single points of failure. Therefore, a significant capability that must be present within the information plane is defensive information warfare or information protection. The network must be able to protect itself from both enemy action and the inherent frailties of information systems.[28] Throughout the development of information systems the need for security has always reduced potential capability.

[28] Information Paper. p 3.

The shooter or engagement capabilities of the network create effects on the enemy. In breadth this covers the full spectrum from nuclear weapons to individual rifleman, lethal to nonlethal, to include offensive information warfare. In depth it also includes the capabilities to plan, select and execute firing solutions. Theoretically, by connecting all "shooters" across the battlespace, they can use the same information to develop simultaneous firing solutions, allowing commanders to "Mass the effects of geographically dispersed air, ground, and sea based shooters in a more responsive and lethal manner."[29] At the same time the selection of the firing units can be accomplished by the network or presented as options.[30]

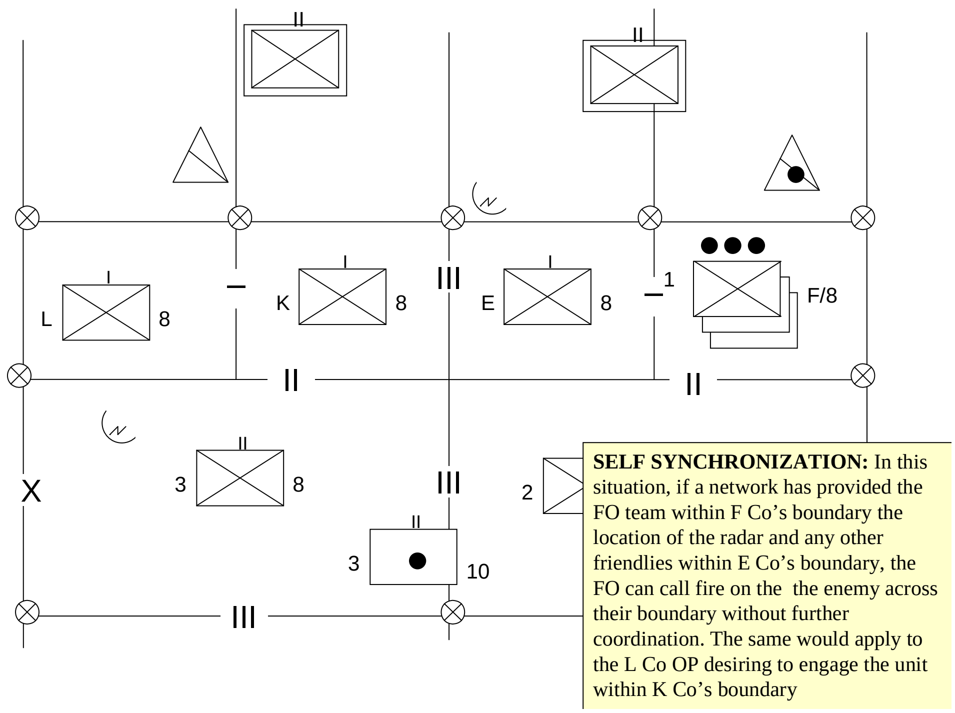
One of the benefits of increased knowledge of the situation, primarily friendly, is the concept of self-synchronization. This is known to Marines as simply conducting coordination at the lowest level possible. The best example is again provided from fire support coordination.

In order to prevent fratricide, the commander's basic question to those sharing his battlespace is "where are you, so that I may ensure the effects of my fires do not impact you." Given this knowledge, a commander must still obtain permission to allow the effects of his own fires to cross into battlespace allocated to another. These steps take time and effort, greatly reducing the potential effect on the enemy. As expressed by VADM Arthur Cebrowski, Director, Space, Information Warfare, Command and Control (CNO-N6), former Commanding Officer of USS GUAM and a carrier battle group during the Persian Gulf War, "Whenever you coordinate firepower you reduce aggregate firepower."[31]

VADM Cebrowski, a fighter pilot, illustrates this with the example of airspace coordination areas (ACA), used to deconflict surface fires with friendly air. An ACA is created by fire

[29] Information Paper. p 6.
[30] VADM Arthur K. Cebrowski, USN. Director, Space, Information Warfare, Command and Control (CNO-N6). Personal Interview. 7 January 1998.
[31] VADM Cebrowski interview

support coordinators to avoid conflict between friendly aircraft and indirect fires. It is airspace through which pilots may maneuver freely and into which or through which surface fires or their



effects may not pass without prior coordination. At present, this process is done manually and is very time consuming, however, the opportunity exists for the network to accomplish this far more efficiently. Modern navigation systems can provide the precise location of aircraft at all times, and modern missile and artillery systems routinely compute the path of their projectiles. The fusion of this information could be automated via the network, allowing pilots to know and avoid the path of projectiles. It would also allow surface systems to avoid firing if friendly aircraft encroached on the actual trajectory. The efficiencies result from greatly increasing the maneuver space available for pilots, and eliminating the time and effort of manually creating an ACA.

The ground example might be the concept of fire support coordination of cross boundary fires. At present, in order to fire into the battlespace occupied or allocated to another ground commander, the "where are you, so that I may ensure the effects of my fires do not impact you" question must be resolved. If however, the commander desiring to fire already has this information, he may not need to ask. If the network has this information and firing solutions can be developed that automatically solve the "where are you" problem, the question may become nearly moot. It is important to note that this is a complex and dangerous question; the safety assurances inherent in such a capability must be very strong indeed.

The result of the simultaneous development of firing solutions and self synchronization is increased speed of command, which is best defined as the enduring concept of the OODA loop (observe, orient, decide, act). Enhancing speed of command is the goal of NCW. The OODA loop is defined in Marine Corps Doctrinal Publication 6, Command and Control:

> "Importantly, the OODA loop reflects how command and control is a continuous, cyclical process. In any conflict, the antagonist who can consistently and effectively cycle through the OODA loop faster-who can maintain a higher tempo of actions-gains an ever-increasing advantage with each cycle. With each reaction, the slower antagonist falls farther and farther behind and becomes increasingly unable to cope with the deteriorating situation. With each cycle, the slower antagonist's actions become less relevant to the true situation. Command and control itself deteriorates.
>
> The lesson of the OODA loop is the importance of generating tempo in command and control. In other words, speed is an essential element of effective command and control. Speed in command and control means shortening the time needed to make decisions, plan, coordinate, and communicate. Since war is competitive, it is not absolute speed that matters, but speed relative to the enemy: the aim is to be faster than our enemy, which means interfering with the enemy's command and control as well as streamlining our own. The speed differential does not necessarily have to be a large one: a small advantage exploited repeatedly can quickly lead to decisive results. We should recognize that the ability and desire to generate a higher operational tempo does not negate the willingness to bide time when the situation calls for patience. The aim is not merely rapid action, but also meaningful action."[32]

According to VADM Cebrowski, the key to winning is speed of command. "The action component is the key, translating superior information into a competitive advantage."[33] In other

[32] MCDP 6. p 65.
[33] VADM Cebrowski Interview

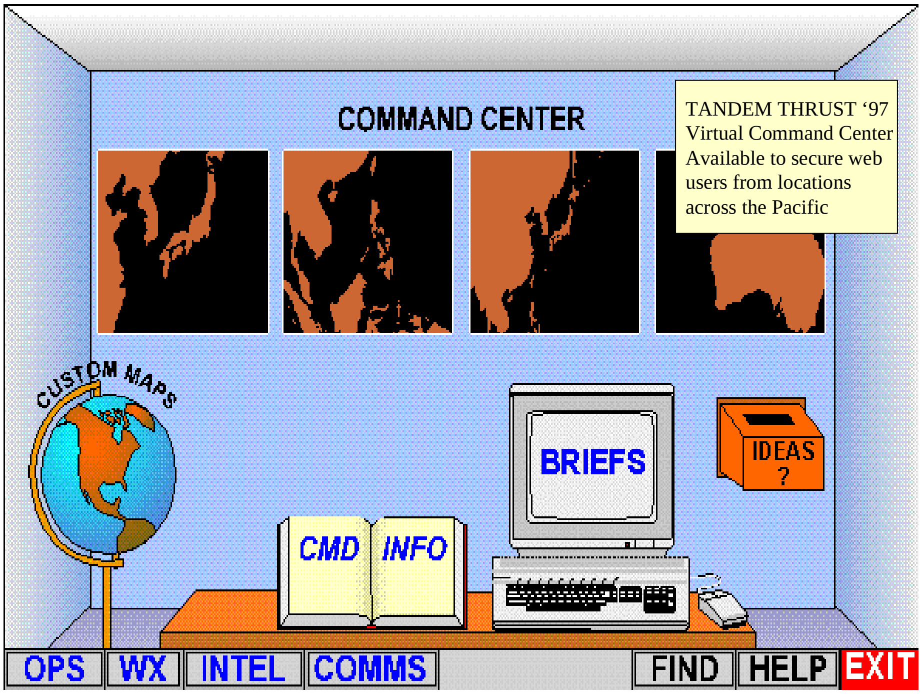
words, the critical question is how to ensure the network is developed to optimally support the MAGTF Commander's speed of command both afloat and ashore?

In order to gauge the impact of NCW as it has already been applied it is useful to look at several current applications. This will help determine the possible impact of current and future applications. Exercise THRUST 97 was a large scale joint exercise sponsored by the Commander in Chief, Pacific (CINCPAC). Participating forces came from all parts of the CINC's area of responsibility (AOR) and converged on the exercise area in Australia. Combined Amphibious Forces under the Commander of the USS ESSEX Amphibious Ready Group (ARG) arrived from the Persian Gulf, the USS INDEPENDENCE Carrier Battle Group and 31st MEU aboard the USS NEW ORLEANS from Japan. The Commander, Combined Task Force (CCTF) and Joint Forces Air Component Commander (JFACC) arrived aboard the USS BLUE RIDGE. B-52's and US paratroops flew from the continental United States.[34]

The significance of the arrival of these far-flung forces is the level of planning that was undertaken throughout their movement to the exercise area. Rather than be restricted to the traditional message traffic, the converging forces also used various forms of data, voice, and video-teleconferencing (VTC). This made very effective use of the available total network to support the CCTF's planning.[35]

A significant element of this network was the use of the familiar worldwide web technology. By using secure web sites, participating commander's and staffs were able to pull only the information they required rather than have an entire package pushed to them, of which only a relatively small element was required. This also allowed intermediary levels within the

[34] Mr. Martin C. Jordan. Personal Interview conducted via telephone in conjunction with review of "Observations from Tandem Thrust 97" Brief. 06 January 1998.
[35] Mr. Jordan Interview



chain of command to simply direct subordinates to the location of information required at all levels vice processing and retransmitting information. Each of these steps greatly reduced the amount of actual data transmitted over the networks, making the network more efficient.[36]

By allowing all levels of command to go to the same source for the same information the hierarchy is effectively flattened. This is not without drawbacks, as in some cases it may not be desirable to have subordinates bypass levels in the chain of command.

In some instances, however, it can be quite useful. An example from TANDEM THRUST is the meteorology Web Page which was provided by the Meteorological Center in Guam. All who had access to the network could pull relevant weather information without posing any concern to their chain of command.[37] Message system users do not operate under system restrictions concerning the routing of messages, and this has posed no great difficulty for many years. For TANDEM THRUST 97, such nonlinear information access was a considerable force multiplier.[38]

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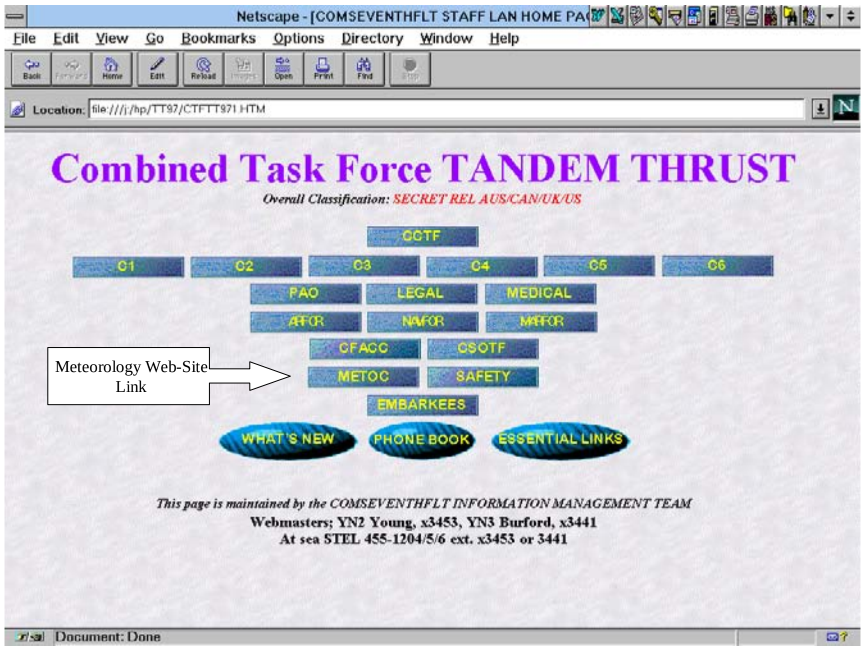
[36] Mr. Jordan Interview
[37] Mr. Jordan Interview
[38] Mr. Jordan Interview

The exercise provided a unique opportunity to test the CCTF’s OODA loop. While the forces were still converging on the exercise area in Australia, a large typhoon developed and tracked through the middle of the exercise.



This required that plans be significantly altered. Norma lly, the effect ofsuch events on a somewhat scripted exercise can be catastrophic, however, for TANDEM THRUST this was not the case. The ability to conduct simultaneous or collaborative planning, move large amounts of information with greater efficiency, and self-synchronize far more effectively allowed for an effective real-world adjustment of the exercise schedule to take place “on the fly.” A traditional measure of this is the level of congestion within standard AUTODIN message delivery systems, with backlogs for routine messages sometimes reaching days. For TANDEM THRUST 97, despite the fact that the message systems did clog up, the network allowed the CCTF and subordinate commanders to bypass this and exercise a sufficient degree of command and control to make the necessary changes.[39]

TANDEM THRUST 97’s network also had considerable limitations. Most significantly, network access was limited to locations or vessels with sufficient bandwidth available to support TCP/IP connections. This is the same problem home internet users have with slow modems. As

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[39] Mr. Jordan Interview

of this writing, home internet users can find some applications slow even with 56Kbps modems. Many smaller ship sin TANDEM THRUST 97 and only 2.4 Kbps, effectively making web technology unusable. At such low data rates it is only possible to exchange basic text E-Mail without any form of attachments, and this was done, notably, with some Allies using firewalls to allow access to the U.S. only SIPRNET.[40]

In most cases, however, the smaller decks, especially the amphibious ships, had no access. The significance of this is that while it can be said that the CCTF was able to use some network centric principles, some of his subordinates were not. For the MAGTF Commander, the inability to access forces aboard LPDs and LSDs via the network denies the benefits of a network centric concept of C4ISR. The only means available to the MAGTF Commander to move information between the ships carrying the MAGTF are the traditional message traffic, single channel radio, and for large amounts of data, flight ferry via helicopter.

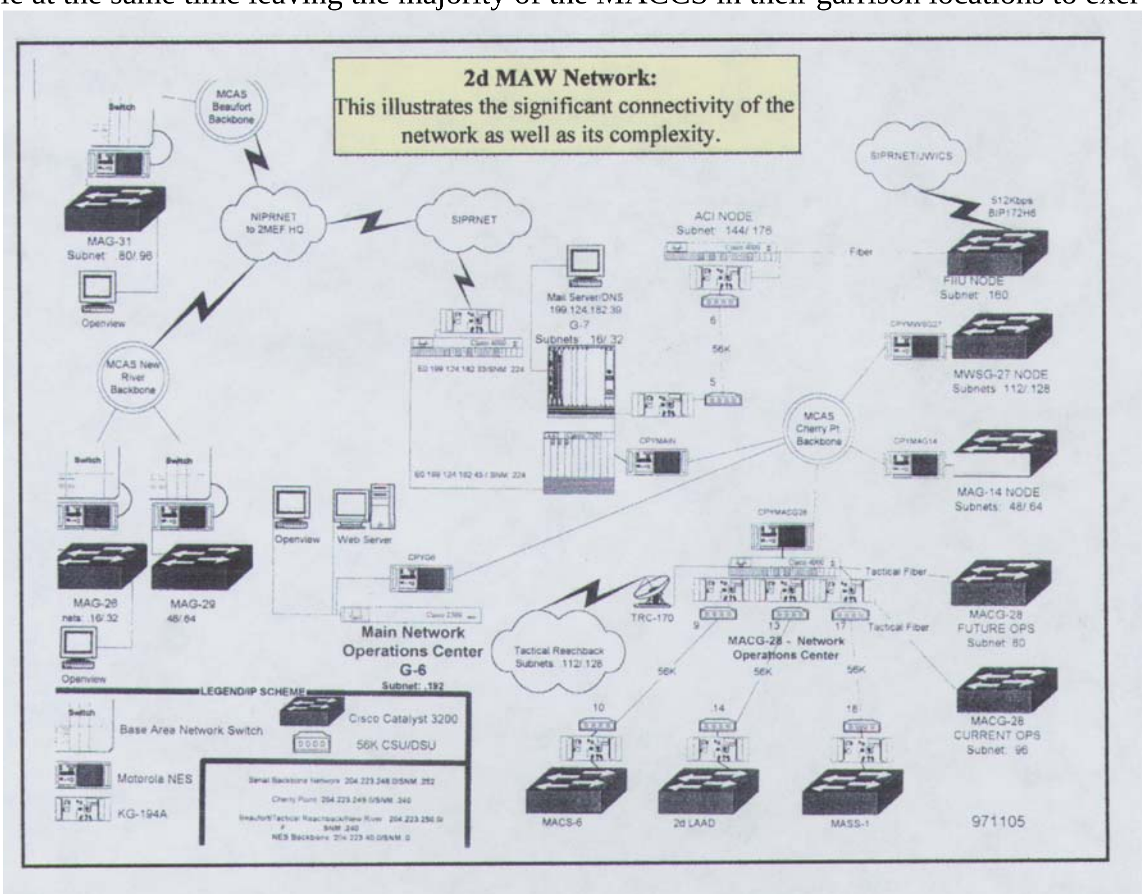
The Marine Corps provides another example of the application of NCW. Within the 2d Marine Aircraft Wing (MAW) the large number of tactical information systems that formed the Marine Air Command And Control System (MACCS) had grown beyond the MAW's ability to effectively train individual and unit skills. A significant complication was presented by the fact that at the time, the number of personnel with network management skills needed to maintain the MACCS systems was shrinking.[41]

These problems arose for several reasons. The MACCS was designed as a tactical system that operated and exchanged information over tactical communications systems. In order to train at any level with the system, the units had to set up significant elements of the tactical

[40] Mr. Jordan Interview
[41] Maj Francis X. Brady, USMC. 2d MAW G-6 Operations. Personal Interview. 23 December 1997.

communications system. In effect, in order to train any part of the MACCS, a large portion of the MACCS had to "go to the field." Not only did it take too many people and too much equipment to train a proportionately smaller audience, it also required a large amount of digital bandwidth to exchange information. This allocation of frequencies and satellite access is in relatively short supply and competes with all joint users of such assets.[42]

The solution called for the integration of garrison networks with tactical communications equipment. This offered 2d MAW the less expensive option of conducting all, or a portion of its' training in garrison. The network could easily be extended to the field via tactical communications systems to achieve training objectives that were best accomplished in a field environment, while at the same time leaving the majority of the MACCS in their garrison locations to exercise.



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42 Maj Brady interview

This greatly increases the value of training and potentially saves significant operations and maintenance funding.[43]

The 2d MAW network design utilizes the SIPRNET as its backbone to connect the tactical systems in hand:

GCCS- Global Command and Control System
TCO- Tactical Combat Operations.
IAS- Intelligence Analysis System
JDISS- Joint Deployable Intelligence Support System
TAMPS- Tactical Aircraft Mission Planning System
TERPES- Tactical Electronic Reconnaissance Processing and Exploitation System
CTAPS- Contingency Theater Automated Planning System

The network also connects or includes the following units at various locations:

2d MAW Cherry Point) to II MEF (Camp Lejeune)
Marine Air Control Group-28 (MACG-28) (Cherry Point)
Marine Aircraft Group- 14 (MAG- 14) (Cherry Point)
Marine Wing Support Group- 27 (MWSG-27) (Cherry Point)
MAGs- 26 & 29 at Marine Corps Air Station (MCAS), New River
MAG- 31 and Marine Air Control Squadron- 2 (MACS- 2) MCAS Beaufort, SC
Field sites via tactical communications systems
All other DOD SIPRNET users[44]

In effect, most of 2d MAW's tactical systems are now connected by SIPRNET in garrison. The available connection to units deployed in the field also allows units that have not deployed to participate in training with those who have, greatly expanding the options available to training managers. Other gains not originally envisioned have resulted as well. Because the system is connected via the SIPRNET, it has access to or can be made available to users beyond 2d MAW. Within the scope of II MEF, 2d MAW has been able to provide both training and staffing support to deployed MEUs that were previously only available through the deployment of a mobile training team, again saving money and enhancing training value.[45]

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[43] Maj Brady Interview
[44] Maj Brady Interview
[45] Maj Brady Interview

Now the MAW is also able to conduct far more of its daily business over the SIPRNET than was previously possible. During exercises, the daily Air Tasking Order (ATO), normally a significant challenge for communications systems, is now distributed using WEB technology throughout the MAW. Savings can be provided in two ways: First, the distribution is far more automated, bypassing normal message traffic; and second, units are now only required to select and pull the information they require instead of having the entire ATO pushed to them. Both result in considerable savings in terms of time, effort and resources.[46]

It should also be noted, however, that this project has not been without its share of difficulty. Most significant has been the shortage of available technical expertise. Without this expertise trial and error resulted in inefficiencies in installation and testing. Additionally, the project has been expensive. A significant portion of the funding has come from a U. S. Atlantic Command C2 initiative, a funding source that may not always be available to commanders who wish to install new systems or networks.[47]

Each of these two examples only begin to capitalize on the potential leverage available from NCW. The network that supported TANDEM THRUST 97 provided a much higher level of understanding across the vast Pacific Ocean and clearly helped the CCTF respond to a real world problem. The percentage of visual information vice text was increased, providing a much more user friendly environment. In his recent article in Proceedings, RADM Robert M. Nutwell, Deputy Director, Space, Information Warfare, Command and Control (CNO-N6B) says, "Collaborative planning afloat will be performed by video teleconferencing and 'virtual

[46] Maj Brady Interview
[47] Maj Brady Interview

whiteboard' instead of by AUTODIN message and helicopter shuttle, shrinking the process from days to hours or minutes."[48]

2d MAW solved some training problems and enhanced their ability to conduct different levels of training without leaving garrison. More importantly, the commander gained the ability to support deployed units with both virtual staffing and training, and gained the ability to interface all or part of the MAW with the rest of DOD.

In TANDEM THRUST, and with the 2d MAW example, a commander connected available or preexisting capabilities to an existing network. Both the network and the connected systems were not envisioned to support such applications, the connections have a certain loss of potential in that many of the different systems, although connected by the same path, are unable to share information.

An example of this is provided by looking at two of the systems 2d MAW has connected to the SIPRNET. Both CTAPS and LAS process targeting information for aircraft, with IAS providing information about the enemy, and CTAPS turning it into specific targets. As originally designed, however, the product from IAS could not be fed directly into CTAPS, nor could requirements such as Bomb Damage Assessment (BDA) be passed from CTAPS directly into IAS. It requires an operator interface. In this case, a very significant savings has been made in the reduction of communications requirements from one path to two. An even greater savings will result when the operator interface is eliminated through automation of functions.[49]

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[48] RADM Robert M. Nutwell, USN. Deputy Director, Space Information Warfare, Command and
Control. "IT-21 Intranet Provides Big Reachbacks. Proceedings. January 1998. p.36.
[49] Maj Vaughn P. Fox, USMC. Director, USMC Battle Staff Training Facility. Personal Interview. 19 December 1998.
Authors Note: According to Michael S. Chmielewski, of the Naval Surface Weapons Center, the Marine Corps and Army's Advanced Field Artillery Tactical Data System (AFATDS), currently scheduled for fielding in 1999, will provide this type of capability from a ground fire support coordination perspective. Elements of information pertaining to surface delivered fires,

IMPACT: THE NAVY-MARINE CORPS TEAM

The critical question then, is how does this affect the MAGTF? These examples demonstrate that NCW will have significant impact on, and can provide considerable benefit to the MAGTF. Because the Navy has already embarked on an implementation of NCW, it is essential to see how the Navy's actions will impact the MAGTF. The changes that the Navy is undergoing to implement Copernicus and NCW are revolutionary.

"The Navy's umbrella strategy for enabling the IT elements of network-centric warfare is Information Technology for the 21st Century (IT-21). It provides for accelerated implementation of customer-led command, control, communications, computers, and intelligence (C4I) innovations and existing C2 systems/capabilities (programs of record)."[50] This accelerated implementation is underway today and has already wrought considerable change to the face of the Marine Corps' most fundamental core capability, amphibious warfare.

The command and control capabilities of embarked Landing Force units afloat are defined, and often restrained, by the communications transmission systems and information processing capabilities of the platforms they are embarked in. Commanders may do no more than the ship's systems allow without leaving the ship.[51] There are several simple truths about these systems that have restrained Landing Force capabilities throughout the development of modern amphibious warfare, most markedly since the development of satellite communications.

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fire support coordination , the ATO and commanders' priorities are all processed by the system.

[50] VADM Cebrowski Article

[51] The process of "deckinounting" USMC tactical radios can provide limited augmentation to shipboard radios, but this tends to produce poor solutions at best.

First, the shipboard transmission systems that move larger amounts of data tend to be far more expensive than the computers that process the information at either end. This is largely because shipboard satellite systems require gyroscope stabilized antennas that are capable of maintaining a continuous connection with a satellite tens of thousands of miles away despite the roughest sea conditions. A simple way to differentiate these in terms of capability is to say that those ships capable of moving larger amounts of data can send and receive imagery such as digital photos or maps easily, while those with lesser capability only possess the capability to move simple text.

Computer systems that were developed to process large amounts of information, such as photos, maps or some processed tactical sensor imagery, were installed only aboard flagships because the communications systems were not capable of providing the data to support them on smaller ships. The primary system to which this applies is now called the Joint Maritime Command Information System (JMCIS). The Marine Corps version of JMCIS is Tactical Combat Operations (TCO). TCO is now the Marine Corps' primary tactical computer application for automated message processing, mission planning, development and dissemination of operations orders and overlays, situational displays with tactical control measures, and LAN/WAN applications. Once the system is fielded to the battalion level, it will be the primary vehicle by which the Marine Corps will capitalize on NCW in the near term.[52] Having evolved through several generations of capability, JMCIS and TCO are now the primary systems that both the Navy and Marine Corps use to interface with the DII COE's primary Global Command and Control System (GCCS).[53]

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[52] U. S. Marine Corps. Concepts and Issues 97. ITIQMC. Washington, D. C. 1997. p 71.
[53] U. S. Department of the Navy. Deputy Assistant Secretary of the Navy (C4IIEW/Space). Amphibious Ship C4ISR Master Plan. Draft. Version 1.0. 27 March 1997. p 4.1-9.

Because both the communications and computer systems are expensive, in the platform centric Navy, the platforms that supported commanders higher up the chain of command tended to get these systems, while those farther down did not. In terms of bandwidth capacity, U.S. Navy ships can be classified as haves and have-riots.[54]

Amphibious ships are likewise either haves or have-nots: The flagships designed to support Commanders of embarked Amphibious Task Force (ATF) and Landing Force (LF) or MAGTF Commander, i.e., the Amphibious Command Ship (LCC) and Amphibious Assault Ship (LHD/LHA), are capable of supporting almost any reasonable information system with careful management by communications technicians. Amphibious ships that are not designated as flagships, the Landing Platform, Dock (LPD) and Landing Ship, Dock (LSD), can only really support low volume voice and text messages.

For numbered fleet commanders embarked on fleet flagships, which are even more capable than the amphibious flagships, the connections to subordinate task force commanders are almost exclusively high capacity links. Thus, the numbered fleet commander is able to use the network to its fullest capability to communicate with subordinate task force commanders. As a result, for the ATF and MAGTF Commanders, there is network access up the chain of command, however, down the chain of command there is little bandwidth. The MAGTF commander may be presented with the option to pull information, but may not present that option

[54] The Navy actually has installed two types of satellite systems that are capable of significantly different capacities. The WSC-6 system is a super high frequency system capable of very high data rates that are more constrained by overall network capacity than the radio itself. The WSC-3 is a ultra high frequency system that is far cheaper but capable of far lower data rates. The WSC-3 was designed in the era when commanders desired largely to send text messages and voice, hence it will easily only support these two media. LCCs, LHD/LHAs have both WSC-3 and WSC-6 installed, LPDs and LSDs have only WSC-3 along with the other line of sight systems each has.

to his subordinates; he must still push what he thinks they might need, largely via traditional systems such as AUTODIN. The MAGTF cannot use collaborative planning, nor can the MAGTFs subordinate commands utilize virtual staffing, as has been done with 2d MAW, unless of course, they are also embarked aboard the MAGTF flagship.[55] To put it into NCW terminology, the MAGTF cannot self synchronize. The MAGTF Commander's speed of command has not been improved.

The Split ARG-5 June. 1997: This has the most significant impact when an amphibious task force's elements are sailing beyond line of sight transmission systems capabilities. As an example, on 5 June, 1997, 22 MEU (SOC) was embarked aboard the USS KEARSARGE (LHD-3), USS PONCE (LPD-15) and USS CARTER HALL (LSD-50). On 5 June, KEARSARGE was off the southwestern coast of Africa supporting OPERATION NOBLE OBELISK, PONCE was off the coast of Albania supporting OPERATION SILVER WAKE and CARTER HALL was off Spain participating in EXERCISE BETACOM. This dispersion of an Amphibious Ready Group (ARG) has become known as "Split-ARG" operations and is so common that training for it has become part of the work-up cycle[56]. In such a scenario, although the MEU Commander is fully accessible and in turn has full access to the network, he is very limited in the capability to exchange information with his subordinates.

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[55] It should be noted that this disparity in command and control capability between the different classes of amphibious shipping should not be misinterpreted. The same disparity exists between aircraft carriers, the flagships of carrier battle groups, and most of their cruiser, destroyer, or frigate escorts. Further, given the model of the MEU sized MAGTF, the same condition will exist ashore. The Marine Corps has no significant data capability to the battalion level. There is a rough parity between the capabilities of a MEU sized MAGTF's capabilities ashore and afloat.
[56] Capt G. W. Ertel, USN. Chief of Staff, Commander, Amphibious Group Two, Former Commander, Amphibious Squadron Four. Personal Interview. 26 February 1998.

Under such circumstances, the MEU Commander, Colonel S. T. Helland, USMC, was forced to spend over half a million dollars from operations and maintenance funds on International Maritime Satellite (INMARSAT) call charges (explained further in the next chapter), to move information to his subordinates on PONCE and CARTER HALL. Col. Helland experienced firsthand the effects of the bandwidth shortfall and expresses the requirement clearly: "Just give me 64Kpbs. I don't need INMARSAT, Battle Group Cellular or any of that other stuff. Just give me SHF capability!"[57] This ARG spent only 22 days in sailing within range of line of sight radio systems.[58]

Additionally, the elements of the MEU aboard PONCE operating in support of OPERATION SILVER WAKE in Albania had virtually no access to the considerable support available from the entire Department of Defense via the network. SILVER WAKE was not the only time, PONCE and the Marines embarked aboard her conducted nine independent exercises or operations throughout the deployment.[59] Considering the cost and risk of deplovin2 forces on such operations, and the network capabilities now available, the failure to provide adequate information capability to embarked MAGTFs is totally unacceptable.

[57] Col S. T. Helland, USMC, Commanding Officer, 22d Marine Expeditionary Unit. Personal Interview. 26 February 1998.
[58] Capt Ertel Interview
[59] Capt Ertel. Col Helland Interviews.

WHAT'S BEING DONE?

Is IT-21 addressing this shortfall? The cost of fitting all amphibious ships with the same systems, and thereby providing the same capacity , would be overwhelmingly expensive.[60] Additionally, a reasonable argument can likely be made that because the smaller amphibious ships cannot embark a commander and staff of the same size, the ships do not require the same bandwidth capacity. The precise bandwidth level is difficult to determine, but it should certainly support the highest level MAGTF Commander's ability to exchange imagery and utilize collaborative planning tools within his MAGTF when it is either sailing within or beyond the range of line of sight systems.

At present, the IT-21 project is pursuing two types of alternative systems to address the bandwidth shortfalls of LPD and LSD class ships. The first of these is a line of sight system that provide a high bandwidth connection to another station either ashore or afloat. The Digital Wideband Transmission System (DWTS) is compatible with U.S. Army and Marine Corps systems and will provide the capacity to support most requirements. The advantage in this system's compatibility with U. S. land forces is that it will become possible to connect to the network via either other LHA/LHD class ships or Army units and Marine Corps units ashore. So long as the LPD/LSD class ships are sailing in company with the flagship the entire force can be connected to the network. Under several recent scenarios such as operations in the Persian Gulf, Bosnia or Somalia, either a land or sea-based connection might provide a viable alternative, especially given the lower level of naval threat. It is even conceivable that under certain scenarios a land-based capability could be positioned ashore specifically to support a naval network connection.

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[60] Mr. Martin C. Jordan. Personal Interview conducted via telephone in conjunction with review of "Observations from Tandem Thrust 97" Brief. 06 January 1998.

This would require both a satellite terminal or other network connection as well as a DWTS capability, and, most importantly, a benign environment. Unfortunately, under many Split-ARG scenarios including the one outlined above with the 22d MEU, DWTS would not support inter-MAGTF's requirements. One advantage of a system such as DWTS, capable of connecting several units locally, is that the information transmitted does not need to leave the area. The other type of solution is satellite systems, which have the advantage of supporting the ship regardless of its location relative either to land or other vessels. However, satellite systems route information thousands of miles into space and perhaps back to the United States before returning it to the theater. There are several systems currently in place or under development.

The first of these is International Maritime Satellite System B (INMARSAT-B), which is a commercial satellite system that provides a 64 Kbps four channel digital signal.[61] The INMARSAT radio systems are in widespread use in commercial maritime activity. INMARSAT-B is currently being installed aboard deploying ARG ships prior to their departure

IT-21 Full Capability Matrix

(FY98/FY99)	RF Mgmt	Reach Back	WB Receive	Internal Dist	Process Securely	Surv Comms
Flagship (2/2)	ADNS2 5/25Khz	CA&SHF NTCSS	CA & SHF	ATM LAN	JMCIS-98 &	EHF LDR
CV/CVN (2/4)	ADNS2 5/25Khz	CA&SHF NTCSS	CA & SHF			IF LDR
CG/DDG/DD (4/8)	ADNS2 5/25Khz	INMSAT B	GBS or SHF or (KU Gapfill)			IF LDR
LHA/LHD (2/4)	ADNS2 5/25Khz	CA&SHF	CA & SHF DWTS or (KU Gapfill)	ATM LAN NTCSS	JMCIS-98 &	EHF LDR
LPD/LSD (4/8)	ADNS2 5/25Khz	INMSAT B	DWTS or (KU Gapfill)	ATM LAN NTCSS	JMCIS-98 &	EHF LDR
SHORE	ADNS2 5/25Khz	DISN ???????	DISN	ATM MAN	JMCIS-98 &	SIPR&NIPR

This matrix shows the planned capabilities for the various CVBG/ARG ships. Note that under WB (wideband) receive, the only listing for LPD/LSD is Gapfiller.

[61] Amphibious Ship C4ISR Master Plan. p D-4

and provides them the ability to move imagery.[62] The drawback to INMARSAT is the cost, which runs between five and eight dollars a minute.

During recent peacetime deployments this connection time has been limited to periods of an hour or less per day. During those times, when there is no connection, no real time sensor input is provided to the network and no real time situational awareness is supported. It tends to best support administrative requirements. It would be unwise to assume that the cost for additional connection time could be borne during wartime. Additionally, the short duration of connections certainly limits training opportunities.

This may be changing. According to Capt Joseph Matos, 22 MEU Communications Officer, several enhancements are being provided to the INMARSAT connection which should reduce cost by more efficiently routing connections and increase utility by providing more options for configuring the systems paths that are easily reconfigured underway. Currently untested by a MEU during a deployment, Capt Matos was optimistic about the systems improvements.[63]

Global Broadcast Service (GBS) is a system of satellites and commercially developed receivers. GBS operates at very high data rates of up to 24 mega bytes per second (MBPS) and is intended to support one-way shore to ship video and data service.[64] The system's receive-only capability provides both advantages and disadvantages. Because it is receive only, it does not require the sophisticated antenna of systems with both a transmit and receive capability. The drawback is that data must still leave the ship via some other means. It is important to note that

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[62] Mr. Jordan Interview: "IT-21 FY98-99 Afloat Implementation Brief"

[63] Capt. Joseph A. Matos, USMC. Communications Officer, Twenty-Second Marine Expeditionary Unit, II Marine Expeditionary Force. Personal interview conducted via telephone. 23 March 1998.

[64] Amphibious Ship C4ISR Master Plan p. D-3

the transmission path is not significant; a request for a large amount of data could leave the ship via INMARSAT and return via GBS. This is called Asynchronous Commuications. Each system would handle the requirement with ease, and the result would be transparent to the user. Most ships receive far more data than they transmit.

Other systems which might provide alternatives are still listed under the category of "gapfiller." A variety of commercial systems are being considered. Among them is the Extremely High Frequency Medium Data Rate Satellite System (EHF MDR), which, if approved, could be fielded as early as 2000. Because these solutions are still being developed, it is best assumed that most candidates are perhaps too remote to assess their impact on the MAGTF.[65] For the near term, the provision of a transmission path to support the embarked MAGTF Commander and his subordinate elements is likely to be a complex issue.

In addition to the transmission systems the current plan for processing systems is to field JMCIS to all amphibious platforms.[66] This also can provide TCO for the MAGTF.[67] Currently, the plan is for MAGTF units to bring their own hardware and "plug-in" to a shipboard capability.[68] The provision of systems to process the information provided does not present the same level of difficulty as providing the transmission path.

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[65] Mr. Jordan Interview
[66] Mr. Jordan Interview
[67] Maj Fox interview
[68] Marine Corps Concepts and Issues p. 71.

CONCLUSIONS

A continuous, high capacity transmission path is not likely to be available for at least the next several years . What is far more likely is some combination of capabilities that achieve the best compromise at the cost of INMARSAT-B, the range of DWTS, the receive capabilities of GBS, and the as yet undetermined capabilities of any gapfiller systems such as EHF MDR. Further, because of the rather complex schedule to install this variety of systems, it is likely that every MAGTF that deploys for the near term will depart with a different set of systems and capabilities. This will certainly result in gaps in coverage, especially during Split-ARG operations, and may certainly impact ship and MAGTF maneuver and potential courses of action.

The USMC Battle Staff Training Facility (BSTF) currently conducts functional analysis to determine MAGTF warfighting requirements, with a focus on development of Command Element (CE) information flow and configuration.[69] Coupled with the emerging concepts of OMFTS/STOM, which indicate that CEs will spend far more time operating afloat, it is absolutely essential that the product of the analysis, done by BSTF and other Marine Corps organizations with similar or related missions, feed directly to the CNO-N6 and the IT-21 program managers as well as others installing capabilities aboard amphibious ships.

It is very important to note at this point that all of the systems and options discussed represent an increase and improvement in capability. If GBS provides a solution to half the problem of moving information on and off smaller amphibious ships this is a major leap forward. INMARSAT B, with its' attendant high cost, does provide commanders options for moving information. What is important to the MAGTF is the specific NCW capabilities these changes provide. Because of this dynamic information technology environment, the MAGTF

[69] Maj Fox interview

Commander, along with his Marine Expeditionary Force and Marine Component Commanders, should have an urgent interest in what is done with NCW capabilities during ship refitting and overhaul. Because of the long term impact on amphbious warfighting, this sense of urgency and interest must be greater than ever before to ensure that the MAGTF NCW requirements are addressed and satisfied.

The U.S. Navy's concept of NCW as implemented through IT-21 will provide significant enhancements to MAGTF command and control capabilities. Command Elements are already seeing significant gains as has been demonstrated in evolution's such as TANDEM THRUST 97.

However, enabling the entire MAGTF is proving to be difficult. As demonstrated in the earlier discussion on the development of Copernicus and NCW, it is a challenge for the Navy to orient on MAGTF requirements either ashore or afloat. Simultaneously, the Marine Corps is developing new ideas about command and control, information flow, and even the shape of information.

There are three levels at which the Marine Corps needs to influence this development. The first and simplest is at the level of the deploying MEU, MEF Forward and Amphibious Group, where decisions about individual items of equipment, the pieces of a capability for a particualr deployment can be influenced. The next is at the Marine Force Commander or Component Commander and Fleet Commander level, where decisions are made that effect capabilities across a numbered fleet or theater. Finally, at the service level, where the shape of future capabilities is decided upon.

A bright note is that during April of 1998 all naval C4 staffs will move into a single building in Crystal City, Virginia. Perhaps this collocation of service level C4 staffs will provide the opportunity to develope a Department of the Navy C4 requirements process that will ensure

MAGTF NCW requirements gain greater and timely visibility with the CNO-N6 and fleet commanders[70]

The way ahead for the Marine Corps is to be very clear and timely in developing and communicating to the Navy, warfighting concepts and especially the associated C4ISR requirements in order to ensure that capabilities afloat provide the right support.

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[70] Douglas M. Black, Col, USMC (ret). former Head, Information Transfer Division (CNO-N61). Personal memo 06 April 1998.

THE FUTURE

The future of NCW holds enormous promise: The capabilities of a network fully interoperable and capable of sharing information across the entire joint force, as well as the U. S. defense establishment is mind boggling. Artificial intelligence capabilities that go beyond individual computers, to include the entire network, will enable speed of command to reach the speed of processors. The warfighting capability presented by information dominance will be orders of magnitude greater than the already premier U.S. capability.

When systems are designed or modified from an NCW perspective, they will be able to share information not only with common applications but with the network as a whole. This will allow the users of applications and the network to capitalize on capabilities that will satisfy requirements as they emerge, rather than after design or re-engineering. To ensure this, future procurement must meet the Joint Chiefs of Staff (JCS) requirement to be compliant with the Defense Information Infrastructure Common Operating Environment (DII COE)[71]

> The DII Common Operating Environment (COE) establishes an integrated software infrastructure that facilitates the migration and implementation of functional mission applications and integrated databases across information systems throughout the Defense Information Infrastructure (DII). The DII COE provides architectural principles, guidelines, and methodologies that assist in the development of mission applications software by capitalizing on a thorough and cohesive set of infrastructure support services.[72]

At the same time, there are many challenges. While networks provide considerable promise of connection and information sharing, they also can pose limitations. At present, any network can become clogged and overloaded, thereby slowing down the speed of information. For some tactical applications this is unacceptable. One such application is Theater Ballistic

[71] U. S. Defense Information Systems Agency. Defense Information Infrastructure Master Plan Version 6.0. 27 June 1997. p 2-1.

[72] Defense Information Infrastructure Master Plan Version 6.0. p B-35.

Missile Defense (TBMD). With modern ballistic missiles possessing times of flight that may be fifteen minutes or less, warning of inbound enemy missiles must reach potential friendly targets within minutes or seconds. Such warning cannot be entrusted to a potentially clogged network. Until some means of assurance, either through guarantee of overall network speed or prioritization, is achieved, tactical applications that require real time information may have to remain unhampered by other network connections.[73] The current CTP and COP capabilities cannot at the time of this writing meet some critical time requirements.

How will NCW change the way the Marine Corps fights? There are a number of challenges that loom ahead. The most difficult for the Army and the Marine Corps is linking the capabilities of the best land based sensor to the network. The individual rifleman sees, hears and feels the most critical information in the battlespace, yet the connection of this, our best "sensor," to the network still lags far behind. Unlike air and sea based warfare, where virtually every sensor and engagement capability is already in some way connected, the greatest promise of the power of NCW has yet to be touched upon.

At the same time, even though we can recognize applications providing tremendous capability using existing technology, their high cost means we must be very selective in developing and aquiring them. Only the most essential capabilities can be chosen, and in an era of declining defense budgets we cannot afford to make mistakes.

It is for the Marine Corps to determine how best to utilize the promise of NCW, both to the MAGTF's combat advantage and to support the joint force. How will NCW change the way the Marine Corps fights? According to VADM Cebrowski, "that's a Marine Corps choice!"[74]

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[73] BGEN R. W. Davis, USAF. Ballistic Missile Defense Organization. Interview. 23 Jan 1998.
[74] VADM Cebrowski interview.

ACKNOWLEDGMENTS

I am very appreciative of the assistance and careful instruction provided by my mentors, Col. D. M. Black, USMC (ret) and LtCol (Col Sel) L. Stein, USMC. Col. Black, for suggesting this topic, opening many doors, and most especially for dedicating valuable time in a challenging time in his own life. Col. Stein, for providing me with the complete freedom to pursue my research as I saw fit, and for tolerating the many mistakes I made as a result. To each of them my thanks for allowing me complete freedom to state my views and conclusions unfettered by any outside pressures.

I am also deeply grateful to the following individuals who each took the time to conduct various interviews or E-Mail discussions to assist my research and subsequently reviewed all or part of my work while in progress and made many very helpful criticisms and comments.

BGEN Richard Davis, USAF, Ballistic Missile Defense Office

CAPT Mark Lenci, USN, Space and Naval Warfare Systems Command (SPAWAR, 051) Chief Engineers Office

Mr. Martin C. Jordan, Space and Naval Warfare Systems Command (SPAWAR, 051) Chief Engineers Office, and Commander, 7th Fleet Science Adviser 1994-1997.

Prof. Rex A. Buddenberg, Naval Postgraduate School, Monterey CA

LtCol (Col Sel) Robert R. Logan, USMC. Marine Corps Combat Development Command, C4I Branch

LtCol Patrick C. Regan, USMC, Staff, Chief of Naval Operations, Expeditionary Warfare (CNO-N85)

Maj. Francis X. Brady USMC. 2d Marine Aircraft Wing, G-6 Operations

Maj. Jeffrey D. Wilson, USMC, Headquarters Marine Corps, C4I

Maj. Michael S. Chmielewski, USMCR FCT 10. Naval Surface Warfare Center, Dahlgren, Va. (Marine Corps Systems Command, Marine Corps Combat Development Command).

Capt. Joseph A. Matos, USMC. Communications Officer, 22d Marine Expeditionary Unit, II Marine Expeditionary Force

ILLUSTRATIONS

The drawings on pages 4 and 22 depicting tactical control measures to illustrate the potential information available to the network, p. 4, and the concept of self synchronization, p. 22, were drawn by the author.

The two web pages reproduced on pages 25 and 26 depicting the virtual command center, p. 25, and the Combined Task Force TANDEM THRUST web page with the link to the meteorology web site, p. 26 are drawn from the “Observations from TANDEM THRUST 97” brief forwarded to me by Mr. Martin C. Jordan.

The graphic on page 28 depicting the 2d MAW network was provided by Maj Frank Brady in conjunction with his interview listed in the bibliography.

The matrix on page 38 which is entitled ‘IT-21 Full Capability Matrix” is drawn from the "IT-21 FY98-99 Afloat Implementation" brief also forwarded by Mr. Martin C. Jordan.

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